

Natural Gas Compressor Stations Greenhouse Gas PSD Applicability Example Sample Calculation Problems

Example 1. Hypothetical Natural Gas Compressor Stations Scenario

Proposed Project: A new natural gas compressor station is proposed to help transport the field gas to the natural gas transmission system. For this example, the facility emitting units consists of one (1) 660 brake horsepower (bhp) compressor engine and one (1) reboiler/dehydrator.

(Note: Other emitting units can exist at a natural gas compressor station but only these emitting units are included for example purposes only.)

Given:

The proposed facility consists of the following emitting units:

1. One (1) 660 brake horsepower (bhp) compressor engine
2. One (1) reboiler/dehydrator

Other miscellaneous assumptions/information:

1. Compressor Engine Fuel Consumption = 8500 Btu/bhp-hr @ Maximum Design Capacity
2. Reboiler Fuel Consumption = 256 MBtu/hr @ Maximum Design Capacity
3. Natural Gas Heat Value = 1020 Btu/scf

Example emission factors for criteria pollutants and greenhouse gases (GHG) associated with the compressor engine and reboiler are provided in the tables below.

Table 1. Compressor Engine Emission Factors

Pollutant	Emission Factors	Units
Particulate Matter (PM ₁₀)	10	lb/MMscf
Sulfur Dioxide (SO ₂)	0.002	g/bhp-hr
Nitrogen Dioxide (NO _x)	11	g/bhp-hr
Volatile Organic Compounds (VOC)	4.4	g/bhp-hr
Carbon Monoxide (CO)	1.4	g/bhp-hr
Carbon Dioxide (CO ₂)	116.87	lb/MMscf
Methane (CH ₄)	0.011014	lb/MMscf
Nitrous Oxide (N ₂ O)	0.000022	lb/MMscf

Table 2. Reboiler Emission Factors

Pollutant	Emission Factors	Units
PM ₁₀	5	lb/MMscf
SO ₂	0.6	lb/MMscf
NO _x	100	lb/MMscf
VOC	8	lb/MMscf
CO	20	lb/MMscf
CO ₂	116.87	lb/MMscf
CH ₄	0.011014	lb/MMscf
N ₂ O	0.000022	lb/MMscf

Problem Solving:

Problem #1. What are the potential emissions associated with the compressor engine and reboiler emitting units?

Example Calculations:

Potential VOC emissions from the compressor engine.

$$\text{VOC Emissions (Tons/yr)} = (4.4 \text{ g/bhp-hr}) * (660 \text{ bhp}) * (1 \text{ lb/454g}) * (1 \text{ ton/2000 lb}) * (8760 \text{ hr/yr})$$

$$= \underline{28.04 \text{ tons/yr}}$$

Potential VOC emissions from the reboilers.

$$\text{VOC Emissions (Tons/yr)} = (8 \text{ lb/MMscf}) * (1 \text{ MMscf/1,000,000scf}) * (256 \text{ MBtu/hr}) * (1000 \text{ btu/MBtu}) * (1 \text{ scf/1020 Btu}) * 1 \text{ ton/2000 lb} * 8760 \text{ hrs/yr} =$$

$$\underline{0.01 \text{ tons/yr}}$$

Please calculate the potential NO_x emission for the one (1) compressor engine in tons/yr using the information provided above.

Please calculate the potential NO_x emission for the one reboiler in tons/yr using the information provided above.

Table 3. Calculated Potential Emissions for the Compressor Engines and Reboiler

Potential Emissions in Tons/yr								
	PM ₁₀	SO ₂	NO _x	VOC	CO	CO ₂	CH ₄	N ₂ O
Compressor Engine	0.25	0.01	70.10	28.04	8.92	2,872.3	0.27	0.00005
Reboiler	0.01	0.00	0.39	0.03	0.08	131.04	0.012	0.000025
Total =	0.26	0.01	70.49	28.07	9.00	3,003.34	0.28	0.00

Problem #2. In terms of mass, what are the total emissions from GHGs?

Total Emissions of GHGs in tons/yr = CO₂ + CH₄ + N₂O (Refer to Table 3.)

$$3,003 \text{ tons/yr} + 0.28 \text{ tons/yr} + 0.000075 \text{ tons/yr} = \underline{\hspace{2cm}} \text{ tons/yr}$$

Problem #3. What are the total emissions of CO₂ equivalent (CO₂e)?

Step 1. In order to determine CO₂e, Refer to Table A-1 of CFR Title 40, Part 98, Subpart A, for the Global Warming Potentials (GWP).

Step 2. Identify the GHG pollutants (e.g., CO₂, CH₄, and N₂O) and their GWPs as shown below.

Pollutant	Global Warming Potential (GWP)
CO ₂	1
CH ₄	21
N ₂ O	310

Step 3. Calculate CO₂e using the following equation:

$$\text{CO}_2\text{e (tons/yr)} = \sum(\text{Mass Emission Rate (tons/yr)} * \text{GWP})$$

$$\text{CO}_2\text{e (tons/yr)} = (3,003 \text{ tons/yr} * 1) + (0.28 \text{ tons/yr} * 21) + (0.000075 \text{ tons/yr} * 310) = \underline{\hspace{2cm}} \text{ tons/yr}$$

$$\text{CO}_2\text{e (tons/yr)} = \underline{\underline{3,009 \text{ tons/yr}}}$$

Summary GHG and CO₂e Emissions:

GHGs (Mass)	CO ₂ e
3,003 tons/yr	3,009 tons/yr

PSD Applicability Summary Analysis:

Question #1: Does this permit action result in an increase of any criteria pollutant above PSD threshold levels?

Question #2: Does this permit action have GHG emissions above the PSD threshold on a mass basis?

Question #3: Does this permit action result in CO₂e emissions above the PSD threshold?

A PSD review would NOT be required for any criteria pollutant because all are less than the 250 tpy threshold for a non-listed source. The answer to Questions #2 and #3 must both be “Yes” for GHGs to undergo a PSD review for GHGs. Because the total CO₂e for the new facility was less than the 75,000 tpy threshold for GHGs, no PSD review would be required for GHGs.

Title V Applicability Analysis/Overview:

Question #1: Are the potential emissions of any criteria pollutant greater than 100 tons per year?

Question #2: Are the potential emissions of GHGs greater than 100 tons per year?

Question #3: Are the potential emissions as CO₂e greater than 100,000 tons per year?

If the answer to Questions #1, #2, and #3 is “Yes”, a Title V permit action to address GHGs are described in the following scenarios.

- A department decision occurring before January 2, 2011, would not require GHGs to be addressed in the Title V permit.
- A department decision occurring after January 2, 2011, must address GHGs in the Title V permit.
- A department decision occurring after July 1, 2011, must address GHGs in the Title V permit.

If the answer to Questions #2 and #3 is “Yes”, a Title V permit action to address GHGs are shown as follows:

- A department decision occurring before January 2, 2011, would not require GHGs to be addressed in the Title V permit.
- A department decision occurring after January 2, 2011, would not require GHGs to be addressed in the Title V permit.
- A department decision occurring after July 1, 2011, would require GHGs to be addressed in the Title V permit.